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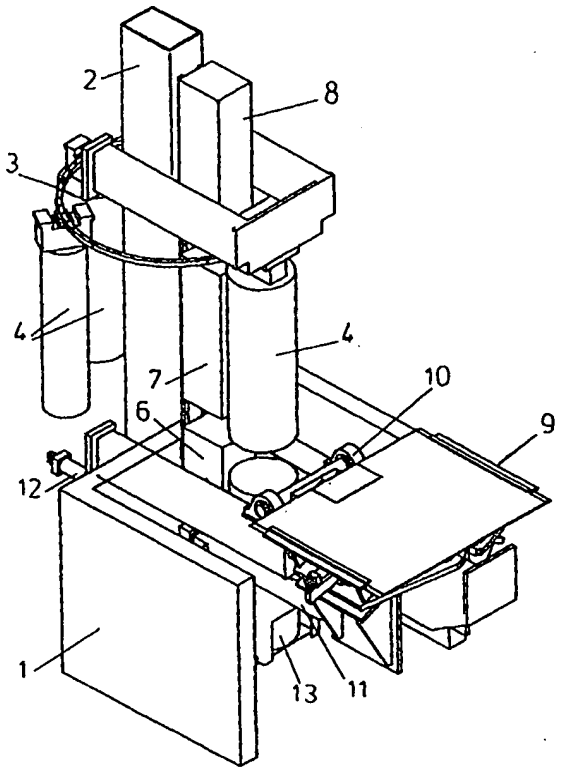
(54) Title: APPARATUS FOR FORMING TUBULAR PRODUCTS AND MANDREL THEREFOR

(57) Abstract

An apparatus for forming tubular products from deformable sheets. A mandrel is located in a predetermined mandrel position and sheets are delivered to the mandrel by a sheet transport mechanism, which is arranged to receive a sheet at a first location in which the sheet lies on a first plane and to transport a received sheet to a second location in which the sheet is adjacent the predetermined mandrel position and lies on a second plane. The mandrel may be arranged generally vertically. The mandrel may comprise first and second pivotally interconnected body parts and an expansion actuator mounted on a movable assembly which can be retracted and rotated away from the mandrel during product stripping and advanced into the mandrel to force the two body parts apart and thereby achieve both mandrel expansion and mandrel end support.



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APPARATUS FOR FORMING TUBULAR PRODUCTS AND MANDREL THEREFOR

The present invention relates to the formation of tubular products from deformable sheets.

Tubular products are used in many industries but in particular in the automobile industry, for example to form body components of car silencer systems. Traditionally, silencer bodies have been formed by wrapping a rectangular sheet of metal around a cylindrical mandrel so that edges of the sheet abut, and securing the abutting edges together by forming a longitudinal lockseam along the body length. The abutting edges of the sheet are interengaged by bending them over and clamping the bent edges together using a series of rollers mounted on a carriage which is moved along a track extending parallel to the axis of the cylindrical mandrel. Given that a series of rollers is required, the roller carriage has a significant length in the direction parallel to the mandrel axis, and the carriage must be displaced by a distance substantially greater than the length of the mandrel. This is because the carriage must be displaced from a starting position, in which it does not obstruct the wrapping of a sheet of metal around the mandrel, to a finishing position, in which each of the rollers mounted on the carriage has moved along the full length of the formed silencer body seam. Carriage displacements of the order of 5 metres are known in machines capable of producing large silencer bodies.

Traditionally the roller carriages have been displaced on a horizontal track located above the mandrel on which the silencer body is formed. Sheets of metal to be wrapped around the mandrel are pushed beneath the mandrel above a sheet bending machine. The sheet bending machine is then extended upwards, wrapping the sheet around the mandrel so that its side edges are located above the mandrel beneath the roller carriage track. The carriage is then reciprocated along the track so as to form the seam.

Given the length and horizontal disposition of the carriage track, the machine has a large footprint. Furthermore, given that a formed silencer tube must be displaced axially when it is stripped off the mandrel after manufacture, the formed

tube must necessarily be discharged to a position beneath the carriage track but displaced horizontally from the position of introduction of the sheet from which the tube was formed. Thus an operator of the machine cannot stand in one place and insert flat sheets to be wrapped around the mandrel as well as removing formed tubes stripped from the mandrel. If the tube forming machine is part of an automated line this is not a problem as sheet insertion and formed tube removal will not require the intervention of an operator, but it is desirable in many applications to produce machines which are suitable for use in cell-production systems. In cell-production systems it is undesirable for operators to have to move between a first position in which a flat sheet is loaded onto a machine and a second position in which the formed tube is made available for removal from the machine. Given that silencer bodies can be produced at a rate of for example one every ten seconds, a machine design which does not require an operator of the machine to move from one position to another would be highly desirable.

Problems are also experienced with the design of the mandrels used in machines for forming tubular products. The mandrels must be expandable so that a tubular product can be formed on the mandrel in its expanded state, the mandrel can then be contracted, and the tubular product can then be stripped off the mandrel. During the tube formation process, the mandrel must be supported at both ends and the support must be removed from one of those ends when the product is stripped. Typically mandrels are formed with two pivotal body parts, the two body parts being pivoted together at the end remote from the end of the mandrel from which the product is stripped. In order to expand the mandrel, an expansion actuator is extended from the end of the mandrel adjacent the body part pivot so as to wedge between the ends of the body parts remote from the pivot, forcing the two body parts apart. Thus a separate powered assembly must be provided to extend and retract the actuator and the assembly is relatively complex given that the actuator must extend along much of the axial length of the mandrel.

It is an object of the present invention to provide an apparatus for forming tubular products which obviates or mitigates the problems outlined above.

According to the present invention, there is provided an apparatus for forming tubular products from deformable sheets, comprising a mandrel located in a predetermined mandrel position, a sheet transport mechanism for receiving a sheet at a first location in which the sheet lies on a first plane and transporting a received sheet to a second location in which the sheet is adjacent the predetermined mandrel position and lies on a second plane, means for wrapping a sheet in the second location around the mandrel, means movable relative to the mandrel for securing together portions of a sheet wrapped around the mandrel to form a tubular product, and means for stripping a formed tubular product from the mandrel, wherein the first plane is inclined to the second plane, and the transport mechanism comprises a sheet support which is pivotal between a first position in which a supported sheet is in the first location and a second position in which a supported sheet lies on the second plane.

The second plane may be vertical so that sheet at the second location is placed in abutment with a vertical mandrel surface. The sheet support may be arranged such that when it is in the second position the supported sheet is in the second location adjacent the mandrel and the wrapping means may be mounted on the sheet support. Alternatively, the sheet support may be arranged such that when it is in the second position a supported sheet is in a third location which is coplanar with but spaced from the second location, the transport mechanism comprising further means for sliding a sheet from the third location to the second location.

A product container may be mounted to pivot with the sheet support and located such that when the sheet support is in the first position a tubular product stripped from the mandrel falls into the container and such that when the sheet support is in the second position a tubular product within the container is readily accessible.

A series of mandrels may be arranged on a track, any one of the mandrels being selectively positionable at the predetermined mandrel position, and upper and lower devices being provided to lock a selected mandrel at the predetermined mandrel position. The lower locking device may comprise an arm which is movable between an engaged position in which it engages and supports a lower portion of the mandrel

at the predetermined mandrel position and a disengaged position in which it is spaced from and does not obstruct stripping of a tubular product from the mandrel.

The wrapping means may comprise a pair of rollers which are displaceable along linear paths that are symmetrically located on either side of a first plane extending through a central longitudinal axis of a mandrel in the predetermined mandrel position and perpendicular to a second plane parallel to a sheet in the second location, the linear paths being located such that advancement of the rollers towards each other also advances the rollers towards the mandrel in a direction with a component parallel to the first plane

Preferably the mandrel comprises a first body part a first end of which is mounted on a first support member, a second body part pivotally connected to the first body part adjacent the said first end, and an expansion actuator mounted on a second support member and displaceable between operative and retracted positions, the actuator when in the operative position being wedged between the first body part and the second body part at a position spaced from the pivotal interconnection between the body parts so as to expand the mandrel, and when in the retracted position being spaced from the mandrel to enable a full product to be stripped from the mandrel.

The body parts may be biased towards each other. Preferably, the expansion actuator is located at a second end of the mandrel remote from the first end and when in the operative position provides support to the second end of the mandrel.

Preferably the expansion actuator when in the operative position extends into an aperture in the first body part and is wedged between a surface defined by the first body part and a surface defined by the second body part. Preferably the surface defined by the second body part is defined by a member extending from the second body part into a further aperture defined by the first body part, the two apertures intercommunicating with each other.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a tube forming apparatus in accordance with the present invention;

Figure 2 is a side view of the machine of Figure 1;

Figures 3 and 4 are views taken on the lines 3-3 and 4-4 of Figure 2;

Figure 5 is a perspective view of the machine shown in Figure 1 after elevation of a sheet support table to position a supported sheet in contact with a mandrel;

Figure 6 is a view similar to that of Figure 2 but taken of the machine in its condition as illustrated in Figure 5;

Figures 7 and 8 are views on the lines 7-7 and 8-8 respectively of Figure 6;

Figure 9 illustrates a sheet wrapping mechanism incorporated in the machine illustrated with reference to Figures 1 to 8 before the start of a sheet wrapping operation;

Figure 10 is a view similar to that of Figure 9 after completion of a wrapping operation;

Figure 11 is view similar to that of Figure 9 midway through a sheet wrapping operation on a smaller mandrel than that shown in Figures 9 and 10;

Figure 12 shows a mandrel and associated locking arm with the locking arm in a disengaged position;

Figure 13 is a view similar to that of Figure 12 after rotation of a locking arm into a position in which it may be engaged in the mandrel;

Figure 14 schematically illustrates an alternative configuration to that of the machine described with reference to Figure 1 to 13;

Figure 15 is a sectional view through an oval section mandrel which may be used in place of the mandrel shown in Figure 12;

Figure 16 is an end view of the mandrel shown in section in Figure 15, the section line of Figure 15 being indicated by arrows 15, 16 in Figure 16;

Figure 17 is a view of a lower end of a first body part of the mandrel of Figures 15 and 16;

Figure 18 is a partial view of an upper section of the first body part the lower portion of which is shown in Figure 17;

Figure 19 is a perspective view of a pusher assembly incorporated in the mandrel of Figures 15 to 18;

Figure 20 is an exploded view of a spring-loaded mandrel contraction device incorporated in the mandrel of Figures 15 to 20;

Figure 21 is an exploded view of a hinge assembly of the mandrel of Figures 15 to 20.

Referring to Figures 1 and 2, the illustrated machine comprises a base 1 from which an upwardly extending mast 2 extends. The mast 2 supports a track 3 upon which mandrels 4 are suspended, a vertical slider track 5 on which a seaming roller assembly is mounted so as to be displaceable from a lower position represented by the box 6 through an intermediate operative position represented by the box 7 to an upper position represented by the box 8, and a sheet receiving table 9 which is mounted to pivot about pivot shaft 10. The table 9 is connected to lever 11 which in turn is connected to an actuator 12. In the illustrated arrangement, the actuator extends to a position behind the machine. In an alternative arrangement (not shown) the actuator can be connected between the table 9 (or a lever attached to the table) and the frame 1.

The rod 12 is displaceable in the direction to the right in Figure 2 so as to cause the table 9 to pivot around the pivot shaft 10. The table 9 also carries a formed product receiving container 13 which is pivotal with the table, the container 13 in the configuration of the machine illustrated in Figures 1 to 4 being aligned with the mandrel positioned on the track in the working position, the seaming roller assembly also being aligned with that working position. The table 9 also supports on its underside a sheet bending mechanism which as described in greater detail below acts on a sheet which in operation of the machine is placed against a mandrel in the working position.

Figures 5 to 8 illustrate the machine of Figures 1 to 4 after rotation of the table 9 through 90° about the pivot 10. Figures 5 to 8 show the sheet wrapping mechanism after it has been extended so as to wrap a sheet around a mandrel in the working position. It will be noted that as a result of the pivotal movement of the table 9, the container 13 has also pivoted through 90° as a result of which the container extends in a generally horizontal direction and a door 14 which was previously closed has swung open to make the interior of the container readily accessible.

Referring now to Figures 9 and 10, the structure and operation of the sheet wrapping mechanism will be described in detail. In each of Figures 9 to 11, the view is taken in the vertical direction after the table 9 of Figures 1 to 8 has been rotated to the position shown in Figures 5 to 8. Figure 9 shows the configuration of the table after it has been pivoted upwards to the position shown in Figure 5 but before initiation of a wrapping sequence. Figure 10 shows the components of Figure 9 after the sheet has been wrapped around the mandrel 4 but before the adjacent edges of the sheet have been seen together. Figure 11 shows the same wrapping arrangement as used with a smaller diameter mandrel 4, the components in Figure 11 being the positions adopted at the end of the wrapping procedure.

Referring to Figure 9, the table 9 supports side flanges 15 which retain a sheet 16 in position as the table 9 is pivoted to the vertical position as shown in Figure 9. Beneath the table 9 a sheet wrapping assembly is mounted on a sub-frame 17 so as to be slidable in the direction of arrows 18 from a retracted position as shown in Figure 9 to an extended position as shown in Figure 10. The sub-assembly comprises bearing bocks 19 guiding rails 20 mounted to brackets 21 which are displaceable. Components 19 and 20 are duplicated on both sides of the assembly but are shown on one side only for the purposes of illustration.

Each of the brackets 21 carries a first hydraulically extendible plate 22 carrying a roller 23 and a second hydraulically extendible plate 24 mounted on pivotal links 25 carried with the plate 22. The guides on which the plates 22 are supported are inclined to the plane in which a sheet to be formed is initially supported. This is advantageous in that when the rollers 23 initially contact the plate to be formed the resultant reaction force on the rollers has a component parallel to the direction of displacement of the plates 22. This reduces any risk of the reaction force causing the plates 22 to be jammed in an extended position. It will be appreciated that as the forming mechanism is initially advanced it is necessary for the plates to be displaced away from the mandrel as the rollers follow the surface around the mandrel. The links 25 are arranged such that in the position shown in Figure 9 the plates 24 are retracted behind and do not obstruct contact between the rollers 23 and a sheet loaded into the

machine, whereas in the position shown in Figure 10 the plates 24 can extend beyond the rollers 23 into contact with the sheet 16.

Starting from the position shown in Figure 9, the wrapping assembly is moved towards the mandrel 4 until the sheet 16 is pressed against the mandrel by the rollers 23. The wrapping assembly then continues to advance as the plates 22 are retracted such that the rollers 23 follow the surface of the mandrel 4, pressing the sheet 16 against that surface. The pressure in the hydraulic actuator (not shown) for the plates 22 is maintained to ensure that the sheet 16 is firmly pressed against the mandrel.

After the rollers 23 have reached a point at which they are separated by a diameter of the mandrel 4, the hydraulic support for the plates 22 is maintained such that the rollers continue to apply a substantial radial force holding the sheet 16 against the mandrel 4. Once the assembly has reached the position shown in Figure 10, the plates 24 are extended to ensure that the vertical free edges of the sheet 16 are correctly positioned for seaming by the seaming roller assembly which is then reciprocated along the mast 2 (Figures 1 and 5). Figure 10 shows the plates 24 in their extended positions.

Referring to Figure 11, this shows the wrapping mechanism of Figures 9 and 10 when used with a relatively smaller mandrel 4. A sheet 16 is shown only partially wrapped around the mandrel. For all mandrels, a sheet can be fully wrapped around a mandrel 4 using only the plates 22 and rollers 23. However it is preferred to extend the plates 24 as shown in Figure 10 as this improves the quality of the seam which closes the sheet around the mandrel.

It will be appreciated that the wrapping process requires robust support for the mandrel at both the top and bottom ends of the mandrel. The top end mandrel support is provided by arranging a support above the mandrel track in the operative mandrel position and the mandrel is pulled into engagement with the support. Once the mandrel has been pulled up and secured by that support, the top end of the mandrel is securely restrained against either axial or radial movement. At the bottom end of the mandrel, a mechanism is also provided which supports the bottom end of the mandrel. The bottom end mandrel support is not shown in Figures 1 to 8 but will be mounted

on for example the base 1 or mast 2. One possible configuration for the bottom end mandrel support is illustrated in Figures 12 and 13.

In Figure 12, the illustrated mandrel 4 comprises two elongate sections the bottom ends of which define surfaces 26 and 27 respectively. The surface 26 defines an aperture 28 into which a pin 29 mounted on a rotatable arm 30 can be inserted. The arm 30 must be swung away from the bottom end of the mandrel when a formed product is stripped from the mandrel by being pushed downward by a suitable mandrel stripping arrangement (which will generally be incorporated in the vertically movable seaming roller carriage assembly) and the arm 30 is shown in Figure 12 in the position it adopts when it is swung clear of the bottom of the mandrel. After a formed product has been stripped from the mandrel the arm is swung through 90° to the position shown in Figure 13 in which the pin 29 is aligned with the aperture 28. The arm 30 is then lifted upwards so that the pin 29 enters the aperture 28. Insertion of the pin 29 into the aperture 28 also actuates a conventional internal mechanism to expand the lower segment of the mandrel. The sheet wrapping procedure is then followed, whereafter the arm 30 is lowered to disengage the pin 29 and rotated to move away from the area beneath the mandrel. Removal of the pin 29 reduces the diameter of the lower segment of the mandrel, making formed product stripping easier.

Product stripping is effected with the machine in the configuration shown in Figure 1 such that a stripped product falls directly into the container 13. During product stripping a new sheet of material to be wrapped around the mandrel is placed on the table 9. Once the sheet is in position and the stripped product has dropped into the container 13, the table 9 is swung upwards to the position shown in Figure 5 and the wrapping process begins. As a result of the movement of the table 9 to the position shown in Figure 5 the container 13 swings upwards and the door 14 swings open so that the formed product can be pulled out by the operator without the operator having to move from the position from which the last sheet of wrapping material was mounted on the plate 9. Thus loading sheets onto the machine and taking formed

products off the machine can be done by a single operator standing in a single position.

In the machine described with reference to Figures 1 to 13, sheets to be formed are placed on a table which is rotated into a position in which the supported sheet is placed directly against the mandrel about which it is to be wrapped. Alternative arrangements are possible however as for example briefly described with reference to Figure 14. In the arrangement of Figure 14, a table 32 can be swung from the position shown about a pivot 33 to a position in which the upper surface of the table 32 is in alignment with a slot 33 defined between a mandrel 34 and a sheet wrapping assembly 35. A sheet placed on the table 32 is positioned in alignment with and immediately below the slot 33 by swinging the table 32 down to a vertical position and a mechanism (not shown) is then used to elevate the sheet into the slot 33. The sheet wrapping mechanism is then operated to wrap the sheet around the mandrel 34.

An arrangement such as that shown in Figure 14 has the advantage that the sheet wrapping mechanism can be mounted on the machine frame rather than on the pivotal sheet receiving table. It is necessary however to provide a reliable mechanism for elevating a sheet into the slot 33 defined between the mandrel 34 and the wrapping assembly 35. In other respects the machine of Figure 14 is substantially the same as that of Figures 1 to 13. As in the case of the machine of Figures 1 to 13, a container (not shown) may be supported beneath the table 32 so as to receive products stripped off the mandrel 34 when the table 32 is in the vertical position and so as to be accessible from beneath the front edge of the table 32 when the table is in the position as shown in Figure 14.

Referring to Figures 15 to 21, the illustrated mandrel comprises a first body part 36 secured to a plate 37 which in use is mounted on a carriage such as that shown in Figure 1. A second body part 38 is pivotally connected to the first body part 36 by a hinge assembly comprising a first hinge bracket 39 bolted to the plate 37 and the first body part and a second hinge bracket 40 bolted to the second body part. The two hinge brackets are interconnected by a hinge pin 41 which supports a bush 42 (see Figure 21).

The end of the first body part 36 remote from the pivot pin 41 supports a plate 43 defining an aperture 44 through which a mandrel expansion actuator 45 (shown in broken lines) may be inserted. The actuator 45 corresponds to the pin 29 shown in Figures 12 and 13. When inserted, the actuator bears against a pusher 46 which forms part of a pusher assembly shown in Figure 19. The pusher 46 has an enlarged head which is slidably received in a slot defined in pusher block 47, the pusher 46 being retained in the slot by a plate 48. The pusher block 47 is bolted to the end of the second body part 38 and is located so that the pusher 46 projects into a further aperture 49 defined in the adjacent end of the first body part. The apertures 48 and 49 intercommunicate so that the actuator 45 can bear against the end of the pusher 46 when it is inserted into the aperture 44.

The first and second body parts 36, 38 are biased together by a spring assembly details of which are shown in Figure 20. That assembly comprises a spring housing 50 which is bolted to the second body part and a spring nut 51 which is retained within a slot defined inside the first body part 36. A spring 52 is retained inside the spring housing 50 by a shoulder screw 53 that is screwed into the nut 51. Thus the spring 52 is compressed, biasing the second body part 38 towards the first body part 36.

The aperture 44, actuator 45 and pusher 46 are dimensioned such that insertion of the actuator into the aperture 44 causes the pusher 46 to be pushed back as a result of the actuator being wedged between the pusher and the wall of the aperture 44. This causes the first and second body parts to pivot apart around the pin 41 against the biasing force provided by the spring 52. Thus the mandrel is expanded to a position in which a tubular product can be formed around it. The actuator 45 also provides lateral support for the end of the mandrel remote from the pivot pin 41. When the actuator 45 is retracted from the aperture 44 it is then swung away as in the case of the embodiment illustrated in Figures 11 and 12. Retraction of the actuator 45 causes contraction of the mandrel under the biasing force provided by the spring 52 and a tubular product formed on the mandrel can then be stripped relatively easily over the end of the mandrel remote from the pivot pin 41.

The mandrel expansion actuator 45 performs two functions, that is controlling expansion and contraction of the mandrel and providing lateral support to the end of the mandrel over which formed products are stripped off. Furthermore, the axial insertion length of the actuator 45 is relatively small. Accordingly the mandrel assembly can be of relatively simple form and only one drive mechanism is required to achieve mandrel expansion and mandrel end support.

CLAIMS

1. An apparatus for forming tubular products from deformable sheets, comprising a mandrel located in a predetermined mandrel position, a sheet transport mechanism for receiving a sheet at a first location in which the sheet lies on a first plane and transporting a received sheet to a second location in which the sheet is adjacent the predetermined mandrel position and lies on a second plane, means for wrapping a sheet in the second location around the mandrel, means movable relative to the mandrel for securing together portions of a sheet wrapped around the mandrel to form a tubular product, and means for stripping a formed tubular product from the mandrel, wherein the first plane is inclined to the second plane, and the transport mechanism comprises a sheet support which is pivotal between a first position in which a supported sheet is in the first location and a second position in which a supported sheet lies on the second plane.

2. An apparatus according to claim 1, in which the second plane is vertical.

3. An apparatus according to claim 1 or 2, wherein a supported sheet is in the second location when the sheet support is in the second position.

4. An apparatus according to claim 3, wherein the wrapping means is mounted on the sheet support.

5. An apparatus according to claim 1 or 2, wherein the sheet support is arranged when in the second position to support a sheet in a third location which is coplanar with but spaced from the second location, and the transport mechanism comprises means for sliding the sheet from the third location to the second location.

6. An apparatus according to any preceding claim, comprising a product container mounted to pivot with the sheet support and located such that when the

sheet support is in the first position a tubular product stripped from the mandrel falls into the container and such that when the sheet support is in the second position a tubular product within the container is readily accessible.

7. An apparatus according to any preceding claim, comprising a plurality of mandrels any one of which may be selectively positioned at the predetermined mandrel position, and means for locking a selected mandrel at the predetermined mandrel position.

8. An apparatus according to claim 7, wherein the mandrels are supported on a track, and the locking means comprises an arm which is movable between an engaged position in which it engages and supports a lower portion of the mandrel at the predetermined mandrel position and a position in which it is spaced from and does not obstruct stripping of a tubular product from a mandrel at the predetermined mandrel position.

9. An apparatus according to any preceding claim, wherein the wrapping means comprises a pair of rollers which are displaceable along linear paths that are symmetrically located on either side of a first plane extending through a central longitudinal axis of a mandrel in the predetermined mandrel position and perpendicular to a second plane parallel to a sheet in the second location, the linear paths being located such that advancement of the rollers towards each other also advances the rollers towards the mandrel in a direction with a component parallel to the first plane.

10. An apparatus according to any preceding claim, wherein the mandrel comprises a first body part a first end of which is mounted on a first support member, a second body part pivotally connected to the first body part adjacent the said first end, and an expansion actuator mounted on a second support member and displaceable between operative and retracted positions, the actuator when in the

operative position being wedged between the first body part and the second body part at a position spaced from the pivotal interconnection between the body parts so as to expand the mandrel, and when in the retracted position being spaced from the mandrel to enable a full product to be stripped from the mandrel.

11. An apparatus according to claim 10, wherein the body parts are biased towards each other.

12. An apparatus according to claim 10 or 11, wherein the expansion actuator is located at a second end of the mandrel remote from the first end and when in the operative position provides support to the second end of the mandrel.

13. An apparatus according to claim 10, 11 or 12, wherein the expansion actuator when in the operative position extends into an aperture in the first body part and is wedged between a surface defined by the first body part and a surface defined by the second body part.

14. An apparatus according to claim 13, wherein the surface defined by the second body part is defined by a member extending from the second body part into a further aperture defined by the first body part, the two apertures intercommunicating with each other.

15. An expandable mandrel for forming tubular products from deformable sheets in a machine in which the mandrel is supported at first and second ends, a sheet is wrapped around the expanded mandrel, the support is removed from the second end of the mandrel and the mandrel is contracted, and the tubular product is slipped from the second end of the mandrel, wherein the mandrel comprises a first body part a first end of which is mounted on a first support member, a second body part pivotally connected to the first body part adjacent the said first end, and an expansion actuator mounted on the second support member and displaceable between operative and

retracted positions, the actuator when in the operative position being wedged between the first body part and the second body part at a position spaced from the pivotal interconnection between the body parts so as to expand the mandrel, and when in the retracted position being spaced from the mandrel to enable a formed product to be stripped from the mandrel.

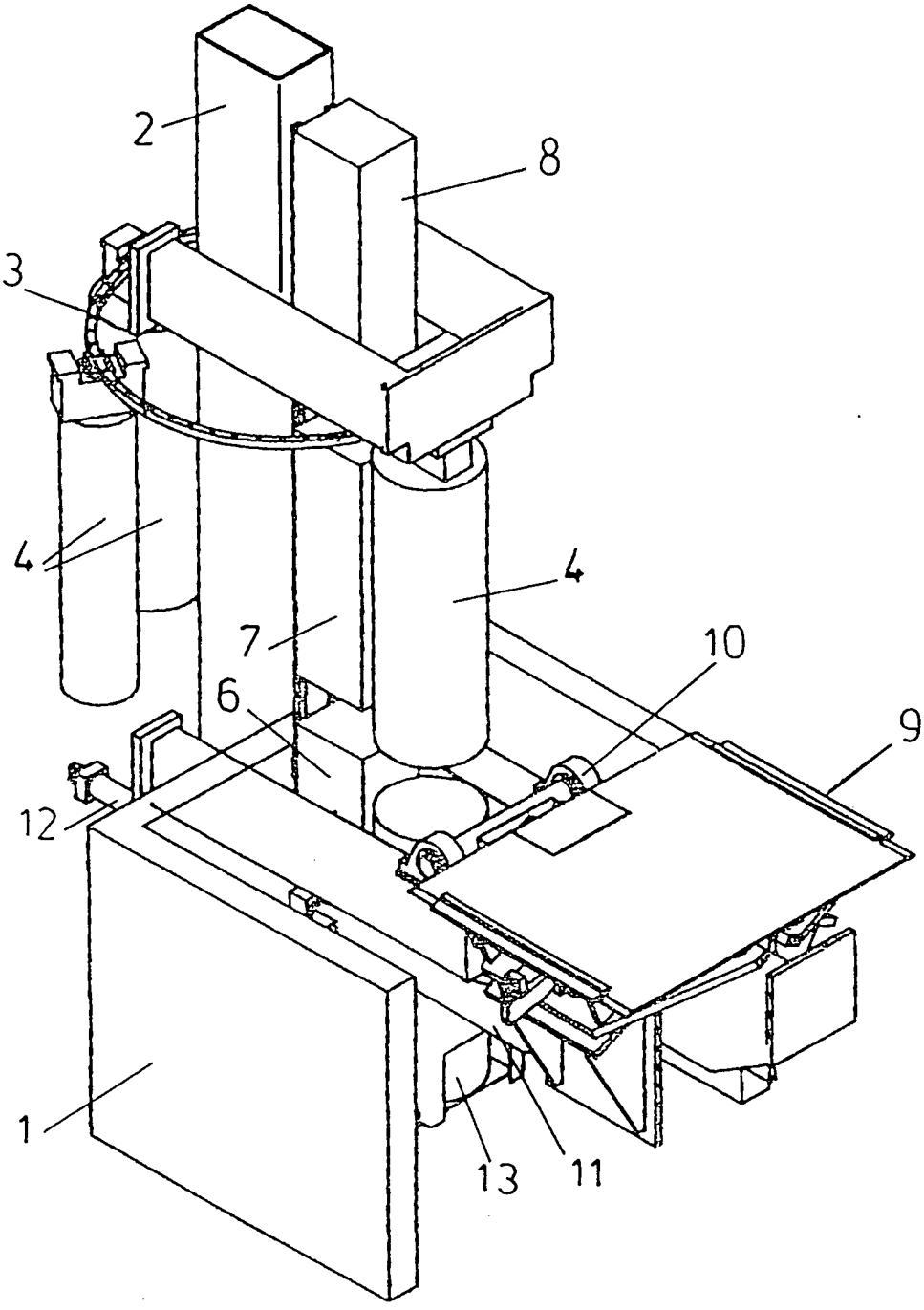

FIG. 1

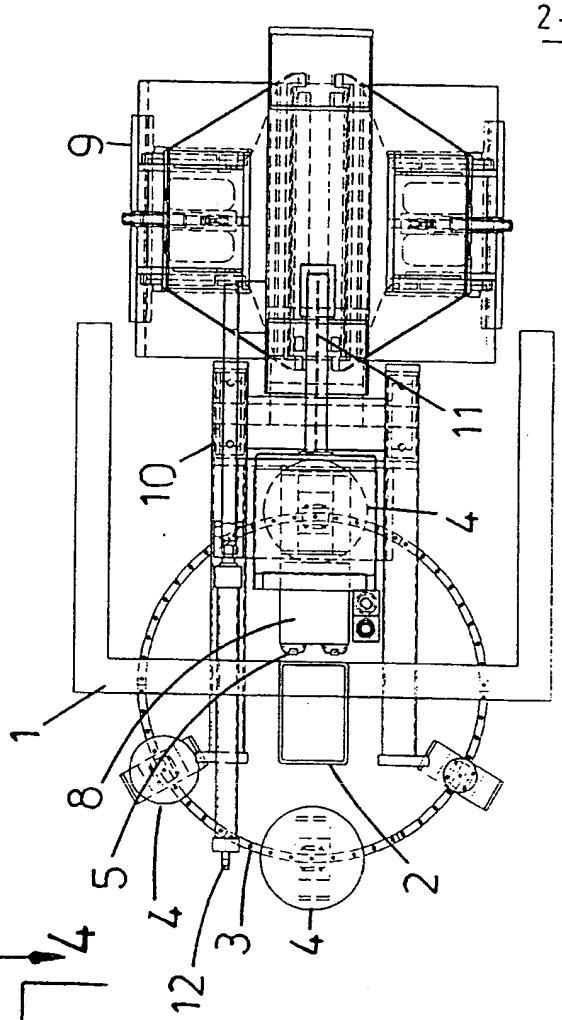

FIG. 4

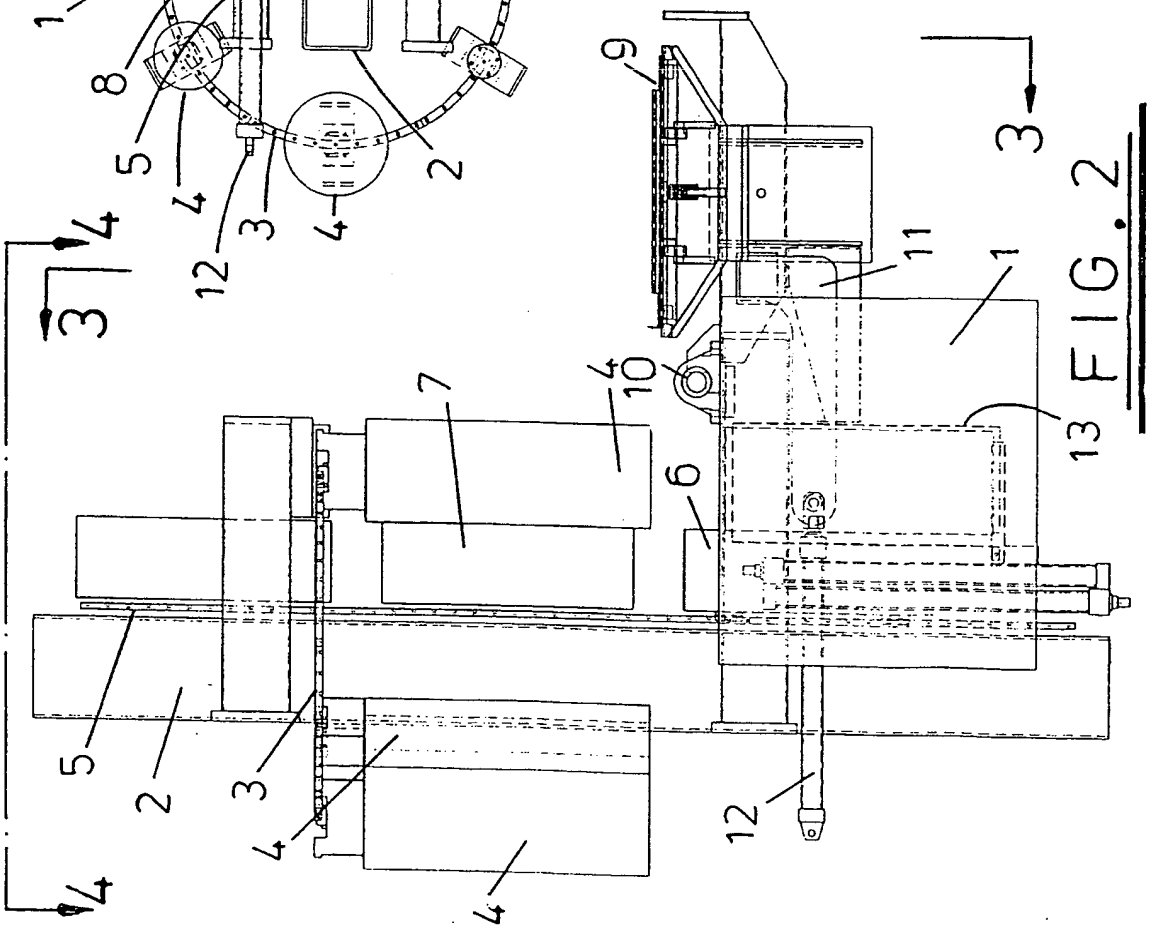

FIG. 2

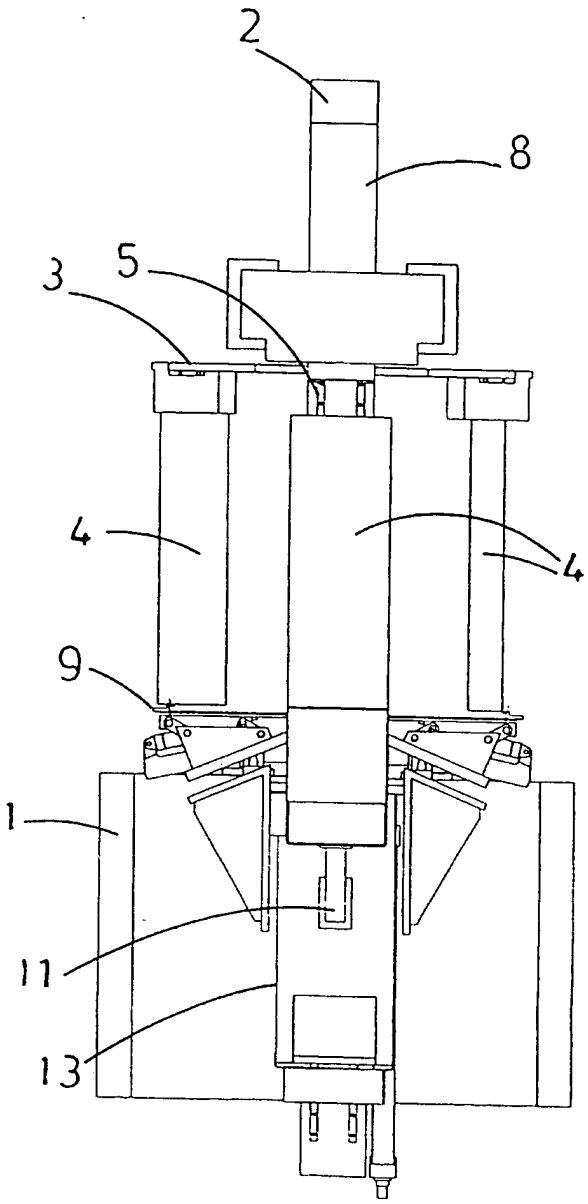

FIG. 3

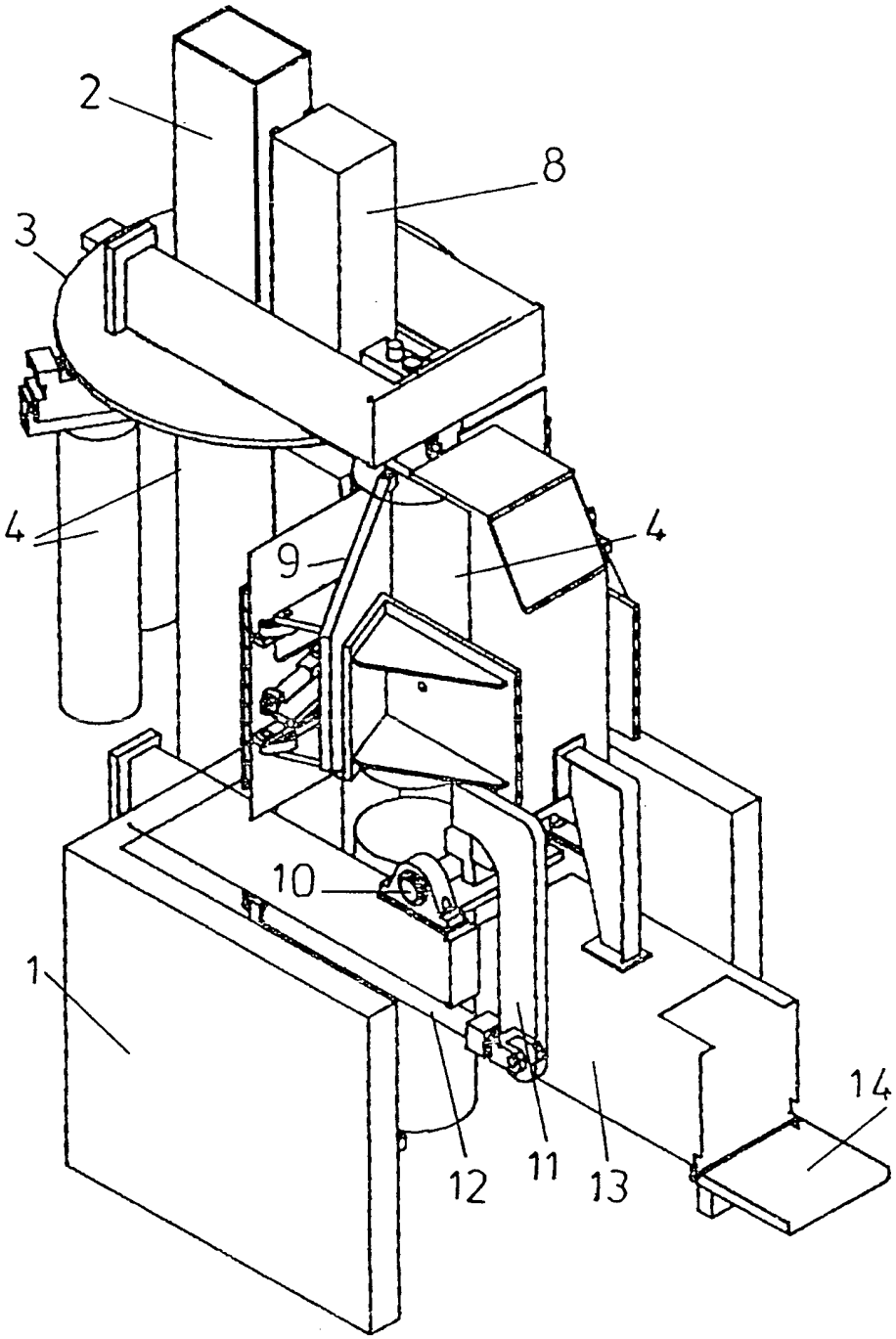

FIG. 5

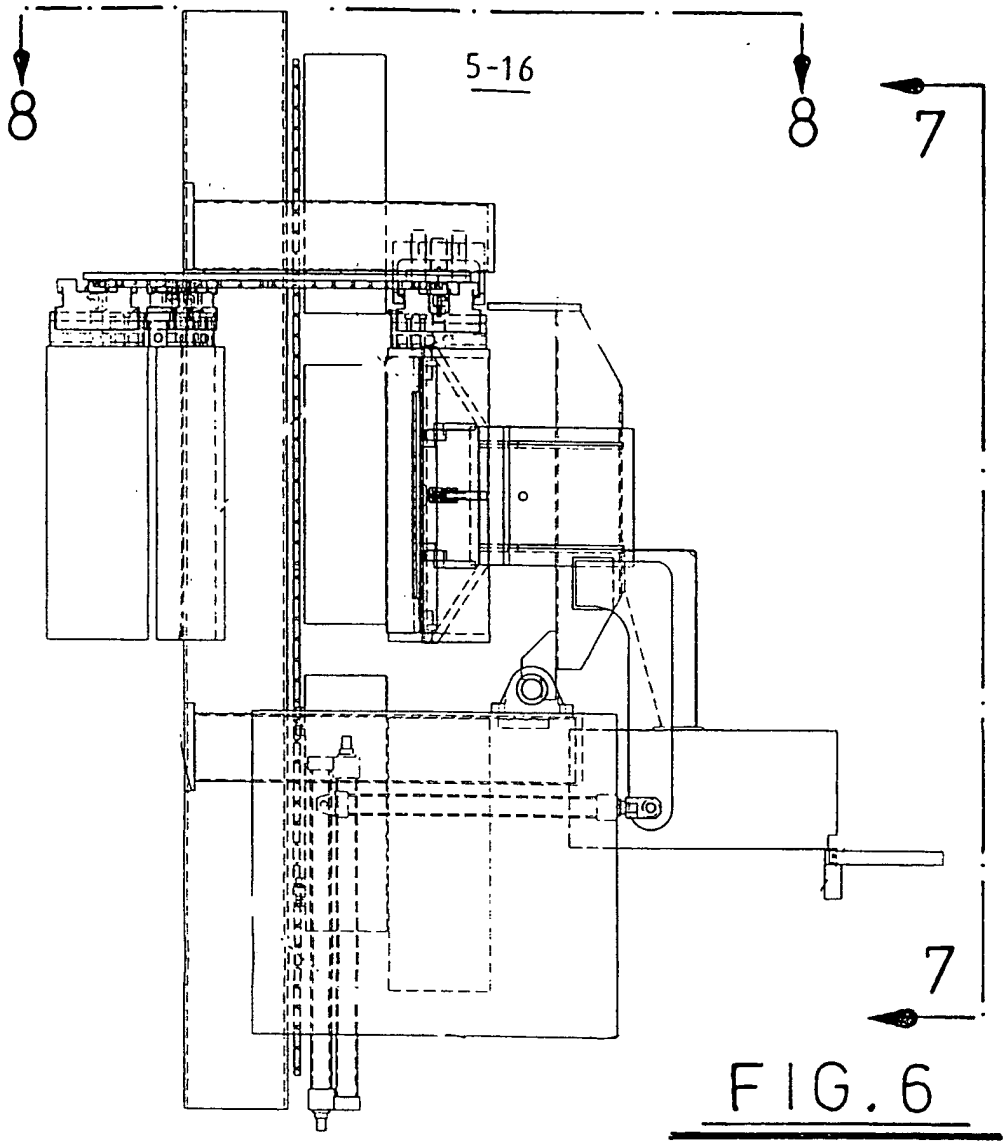

FIG. 6

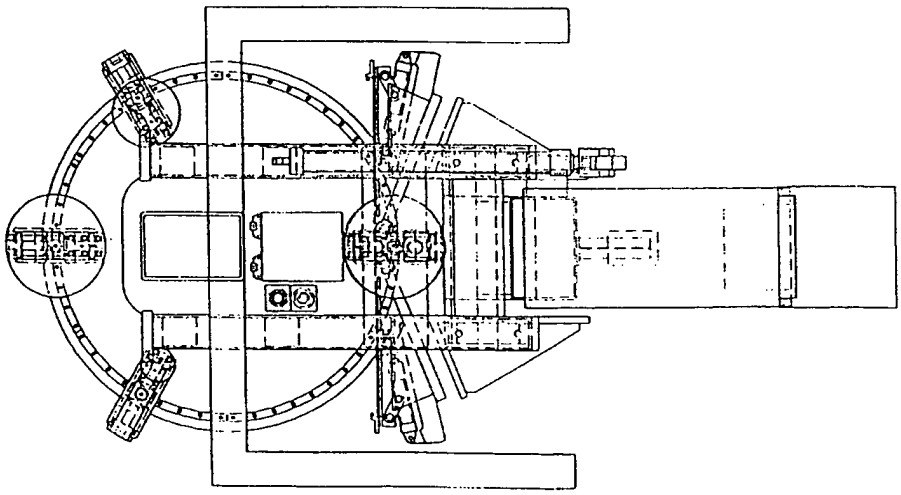

FIG. 8

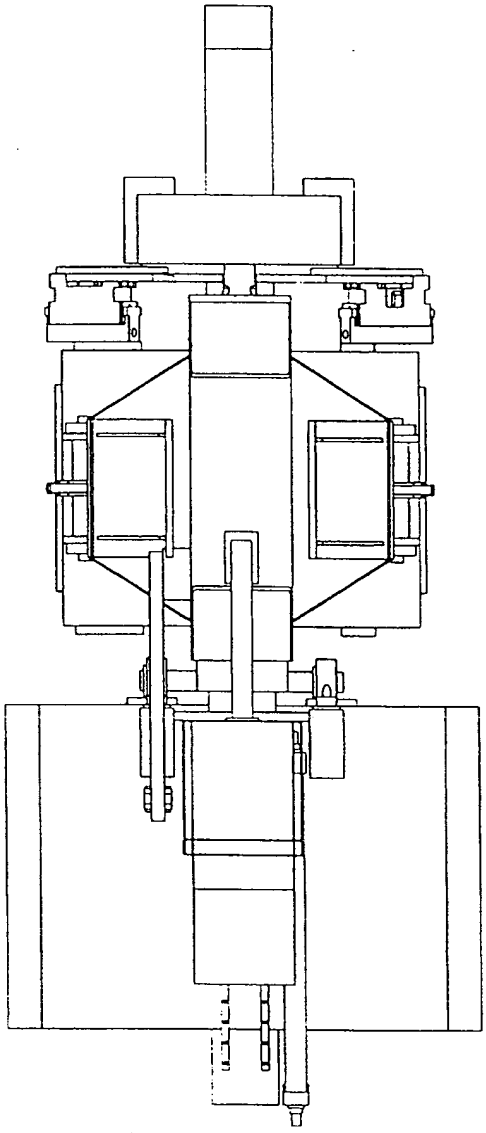

FIG. 7

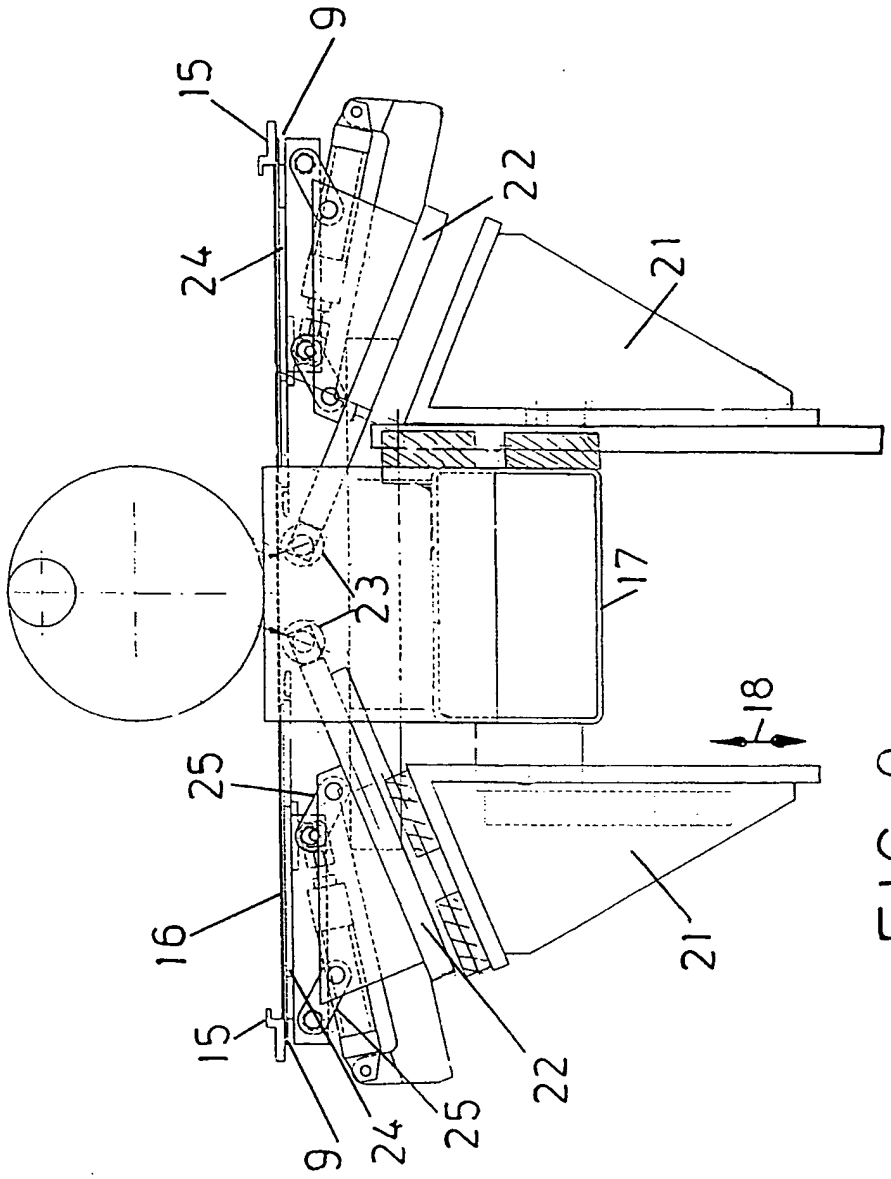

FIG. 9

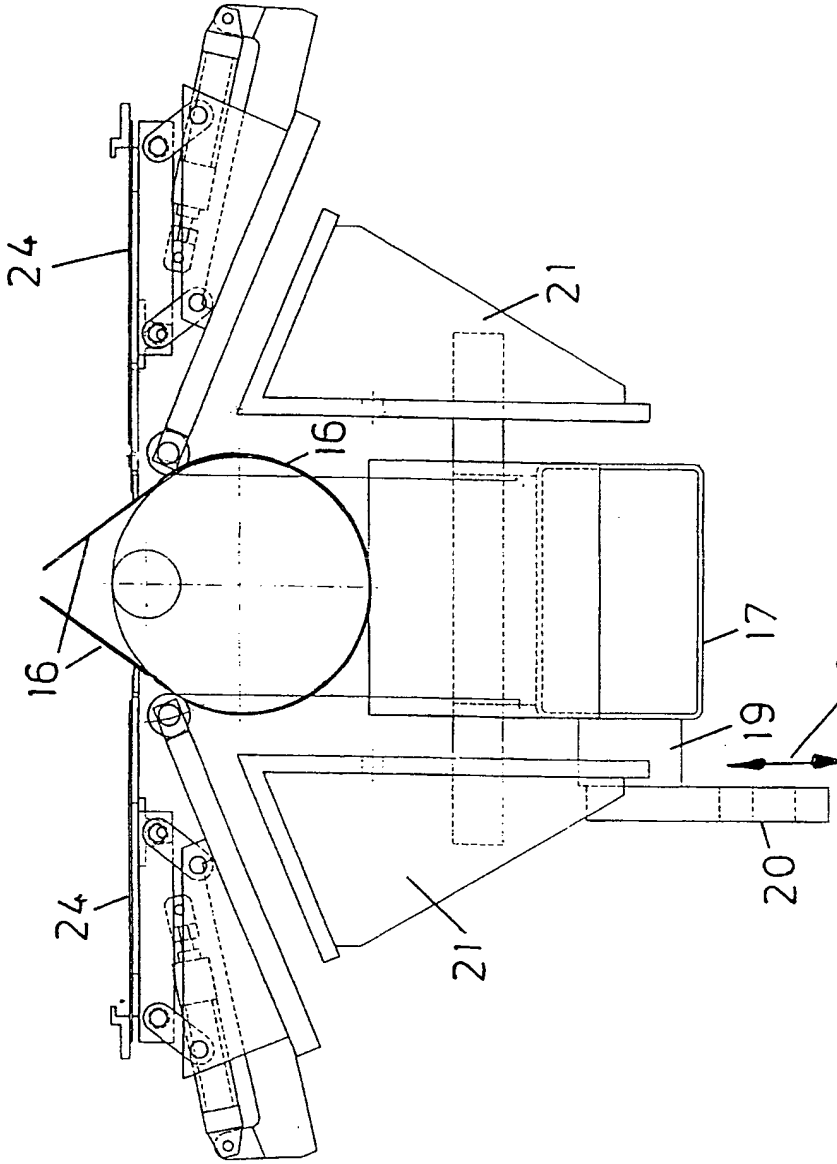

FIG.10

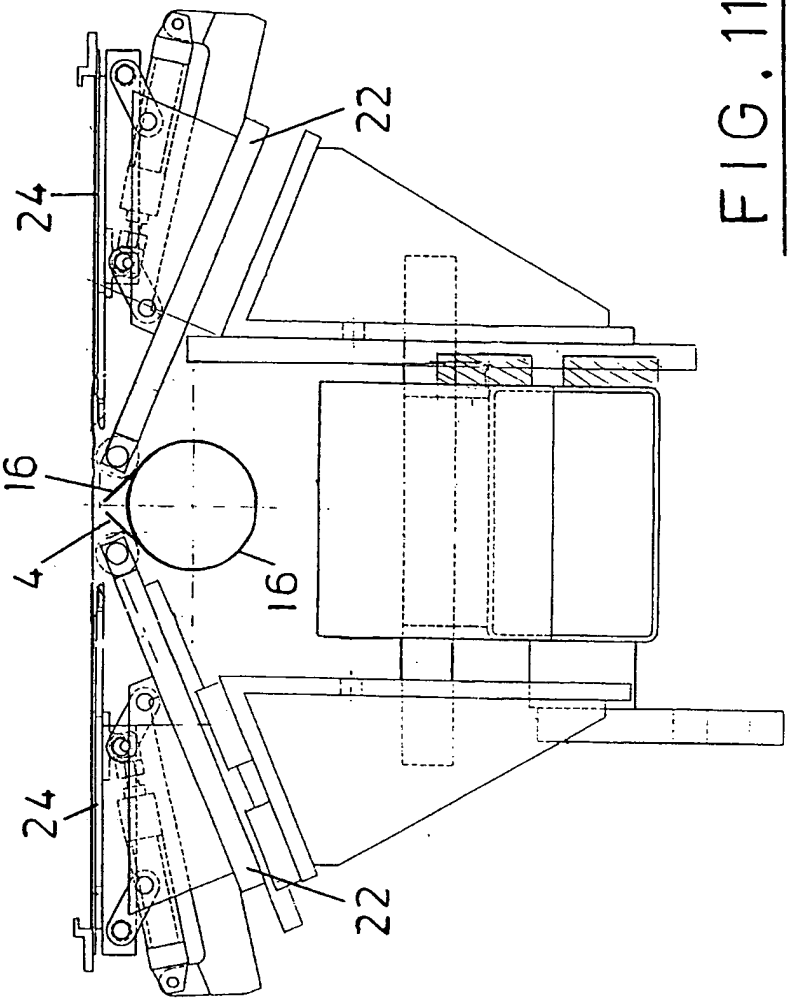

FIG. 11

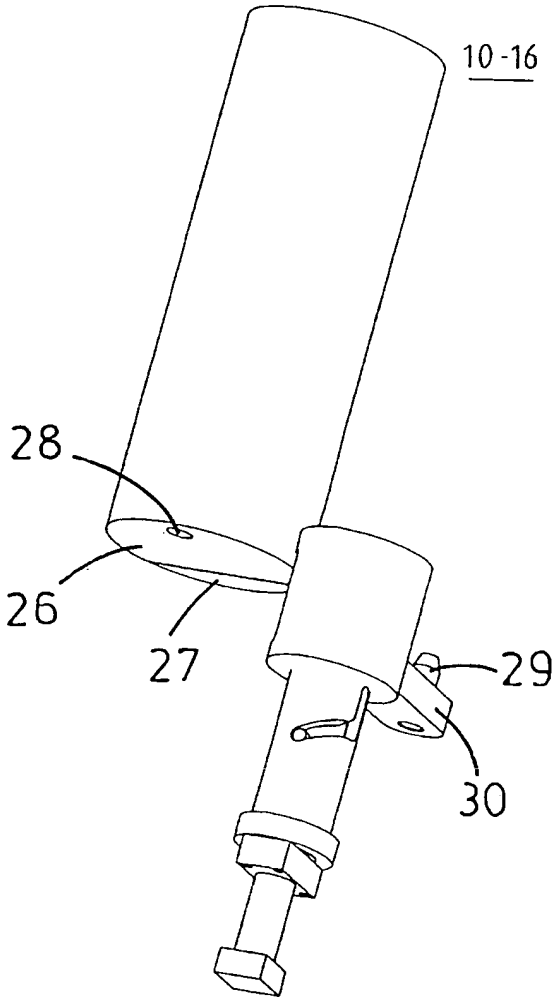

FIG. 12

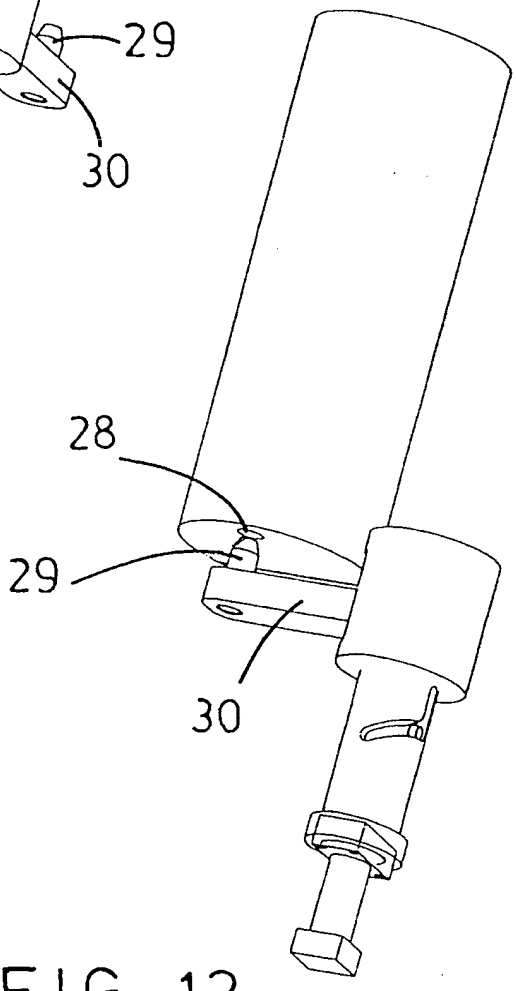

FIG. 13

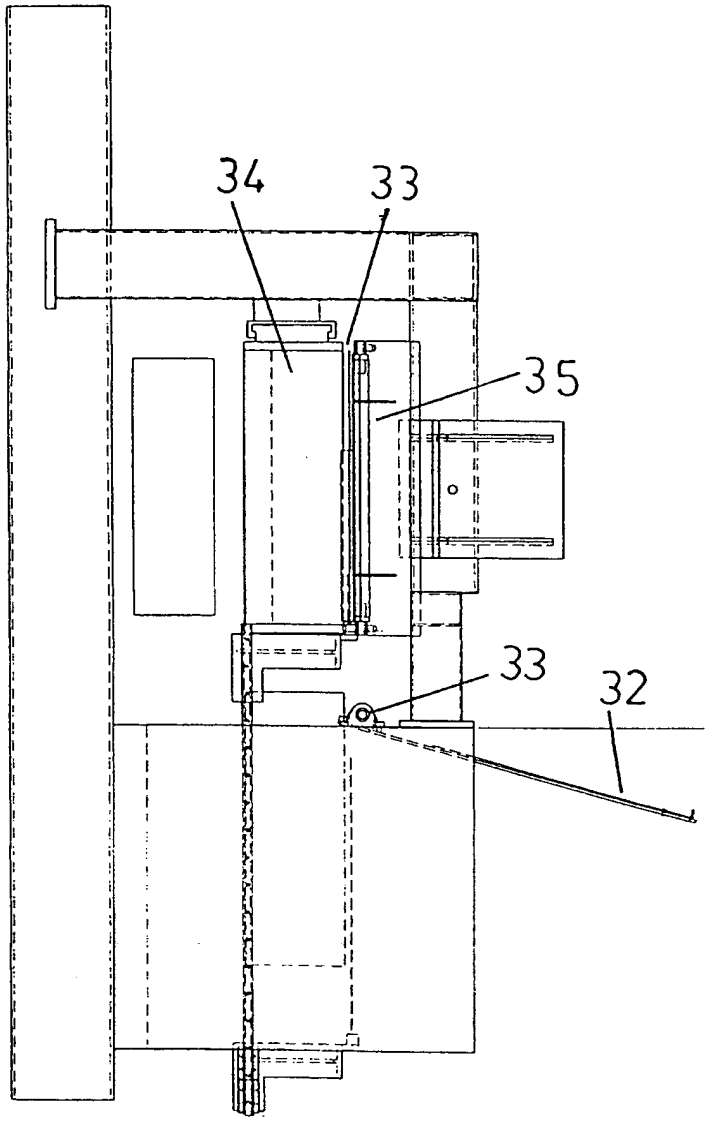

FIG. 14

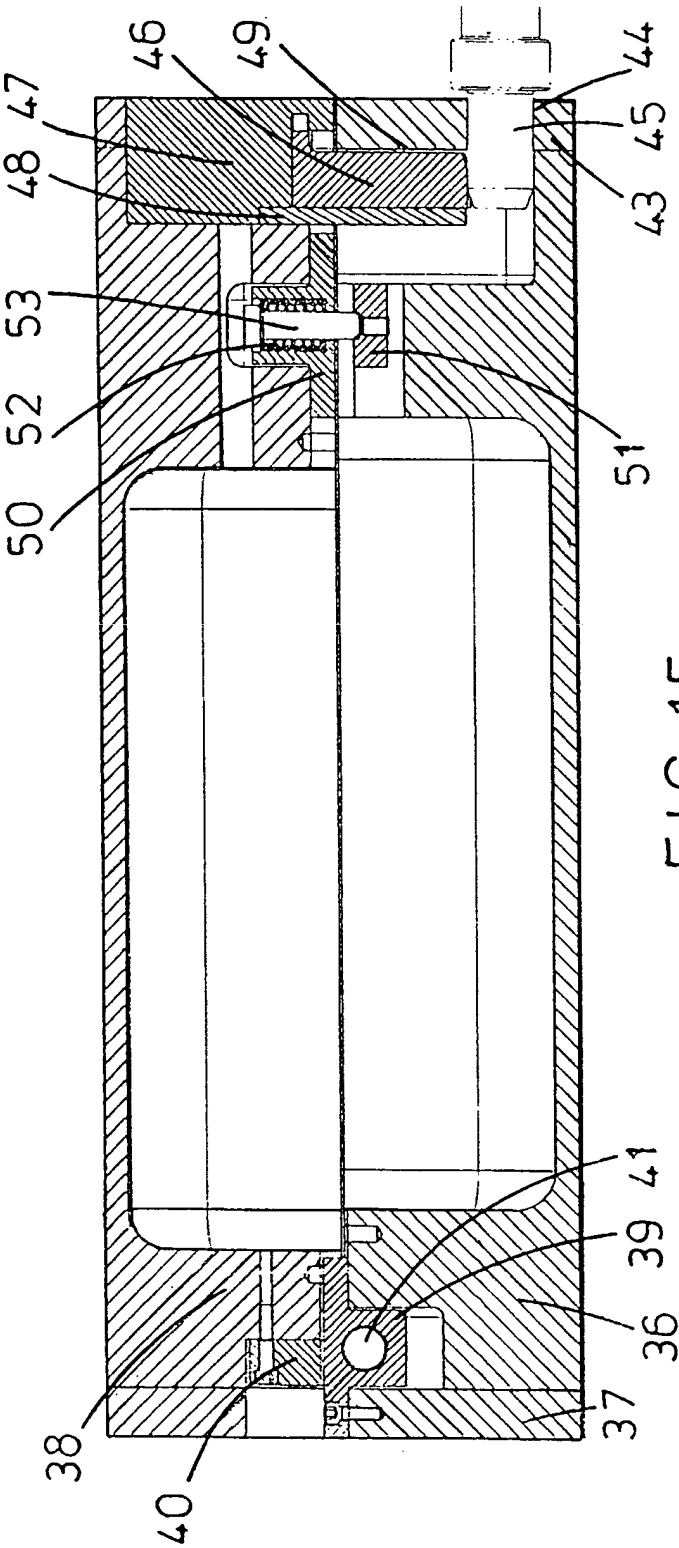

FIG.15

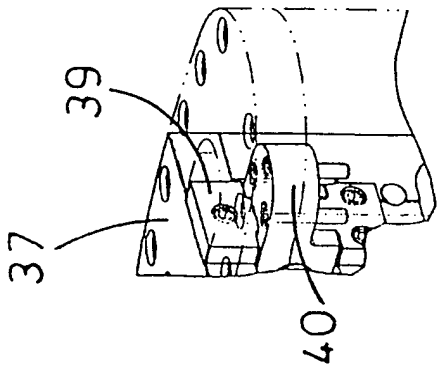

FIG.18

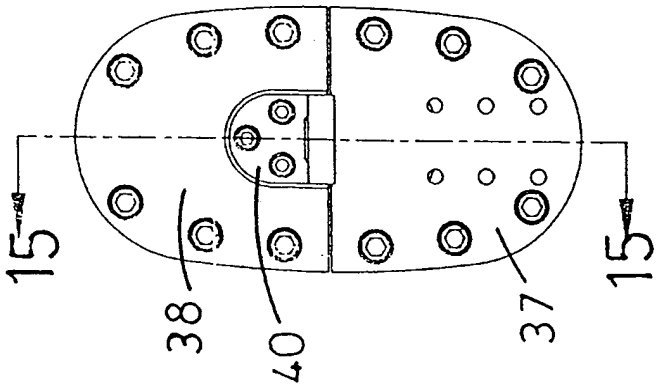

FIG.16

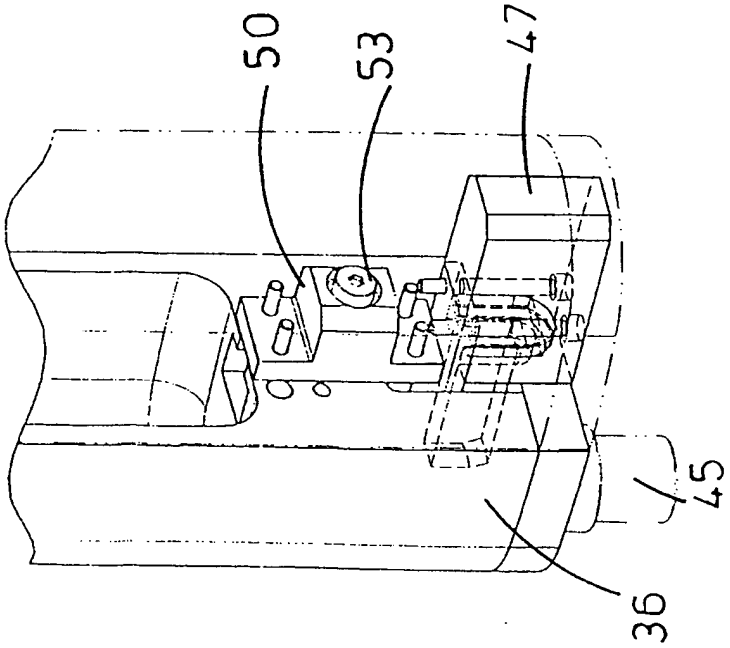

FIG.17

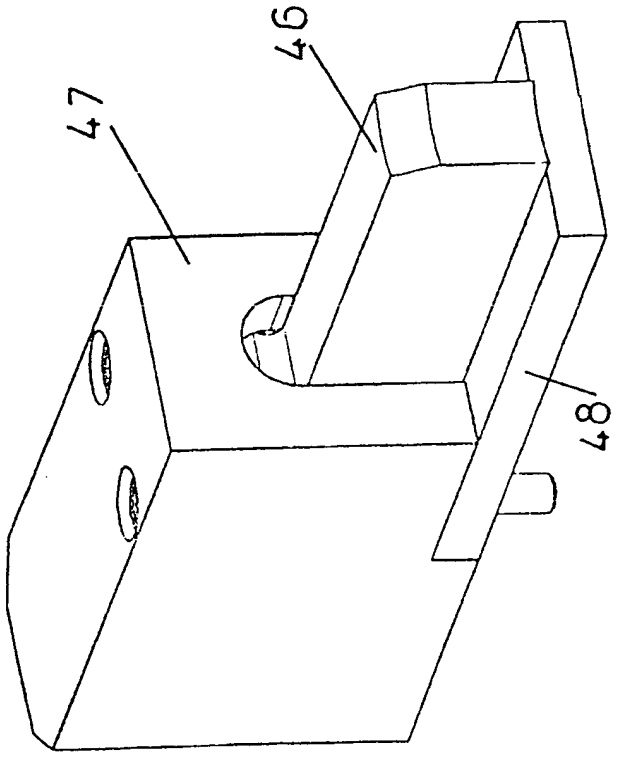

FIG. 19

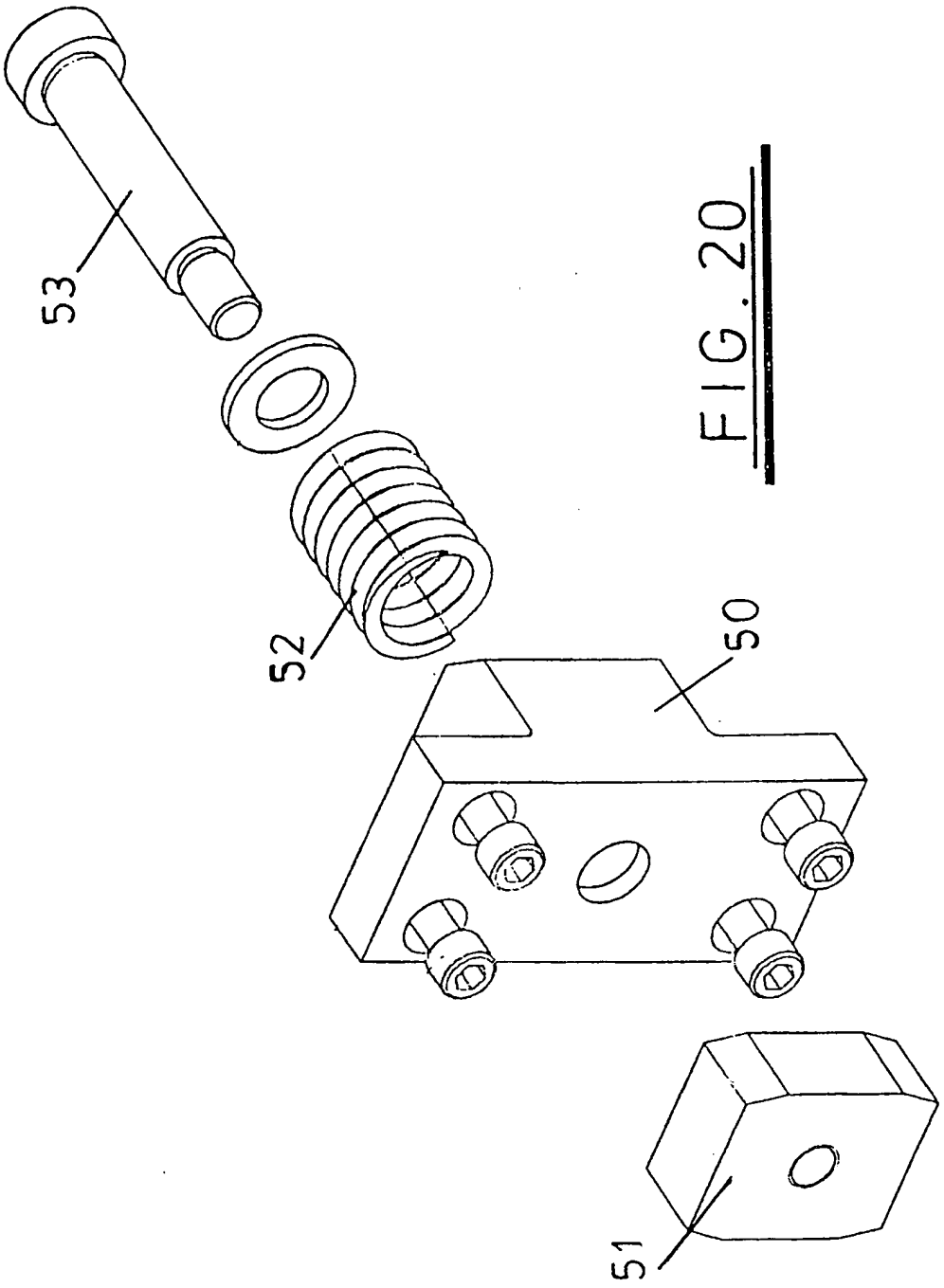

FIG. 20

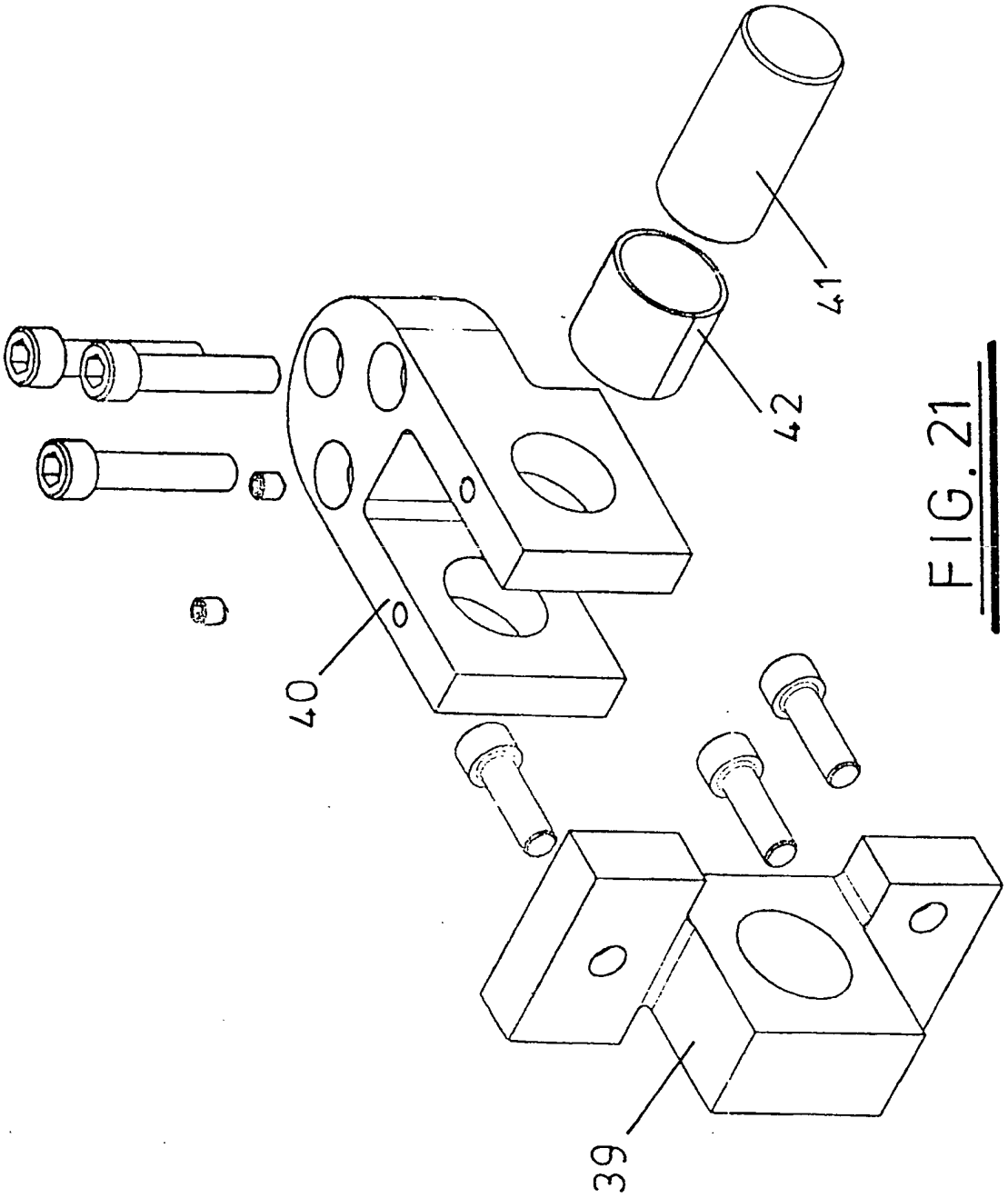

FIG. 21